14.33. **Visualize:** Please refer to Figure P14.33.
Solve: The position and the velocity of a particle in simple harmonic motion are

$$x(t) = A\cos(\omega t + \phi_0) \text{ and } v_x(t) = -A\omega\sin(\omega t + \phi_0) = -v_{\max}\sin(\omega t + \phi_0)$$

(a) At $t = 0$ s, the equation for x yields

$$(5.0 \text{ cm}) = (10.0 \text{ cm})\cos(\phi_0) \Rightarrow \phi_0 = \cos^{-1}(0.5) = \pm\tfrac{1}{3}\pi \text{ rad}$$

Because the particle is moving to the right at $t = 0$ s, it is in the lower half of the circular motion diagram, and the phase constant is between π and 2π radians. Thus, $\phi_0 = -\frac{1}{3}\pi$ rad.
(b) At $t = 0$ s,

$$v_{0x} = -A\omega\sin\phi_0 = -(10.0 \text{ cm})\left(\frac{2\pi}{T}\right)\sin\left(-\frac{\pi}{3}\right) = +6.80 \text{ cm}$$

(c) The maximum speed is

$$v_{\max} = \omega A = \left(\frac{2\pi}{8.0 \text{ s}}\right)(10.0 \text{ cm}) = 7.85 \text{ cm/s}$$

Assess: The positive velocity at $t = 0$ s is consistent with the position-versus-time graph and the negative sign of the phase constant.